



E/CONF.39/A/193

29 Oct.1962

ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: A.3.2.2

Portugal

FLOODS IN TROPICAL REGIONS

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Floods in tropical regions

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- 1 - The flow characteristics of the african rivers and especially the flood discharges to choose for the calculation of the several organs of a hydraulic project are greatly important for the economy of the structures to build up.

The elements determined in the Portuguese Guinea and in Angola as well as in other territories of the west tropical Africa, have revealed differences in respect to the temperate regions, better known by the technicians, from that fact resulting the interest in their study and investigation.

- 2 - As well known, the run-off is the consequence of the climatic characteristics, in special those of the rainfall. The investigations being made by the meteorologists in the tropical regions of Africa have shown peculiar patterns.

So, F. Bultot (1) remarks: that the rains in tropical regions have an "organized" character, that results, after all, from an "organization" of the air termic convection; that the rains on every day are generally grouped in a zone of limited extension, named "rainy zone"; that the rains within the "rainy zones" are not similar to the frontal rains, generally continuous in space and time, of the temperate regions, and, on the contrary, the rains fall under the form of showers; that the "rainy zones" are not constantly fed and so, contrarily to the frontal rains, 24 hours and often larger interruptions can be observed between two successive rain periods. The conclusions of the work were studied in Angola, for the heavy rainfalls of April 1954, by Dario Queiroz, from the National Meteorological Service, who concluded that, in a general way, they could be applied to the rains in Angola. The main observed difference was in the displacement movement of the "rainy zones", which in the Ex-belgian Congo is West to East as most frequent direction whereas in Angola seems to be East to West. Other later works can still be referred to, namely those by D.H. Johnson (2)

(3), where it is stated that, in tropical regions, more important than the amount of rainfall is its distribution and that the big rainfalls have a tendency to occur only in limited regions. So, the area of the region, the density and the total amount of rainfall are closely linked.

- 3 - The tropical rainfall characteristics that have been and are being determined, but are not liable to be easily quantified due to the insufficiency of the rainfall measurement stations existing in Africa, explain, in a large part, the peculiarities that have been and are being known in flows of the african rivers.

In fact, though the great rainfall intensities, for periods running from 10 to 120 minutes, that have been calculated for purposes of drainage and sewerage of rain waters in the great towns of the Portuguese Africa, reach the higher values, when compared with identical values obtained in towns from Europe, Canada and United States, - see Fig. 1 -, the flood discharges calculated for some hydraulic projects of the Portuguese Africa, as well as those obtained in some watersheds of the Africa of french and belgian expressions, give low values, in comparison with those normally considered in the temperate regions.

Therefore, in Fig. II, taken from (4), where such discharges are marked, it can be seen that all of them are located below the Greager curve with $C=30$ (curve v_7), which is the lower involving curve of the maximum floods known in the United States and in other countries of the world. Attention must also be drawn over the marked values accompanying the curve H_3 - Dickens' formula, determined for India, country equally located in the tropical zone.

It must be noticed that the marked points respecting to the Portuguese Africa are project values obtained from discharge measurements made in the corresponding rivers, refering, as a general rule, to a small number of years, and from theoretical considerations based on discussible flood frequency criteria or others. The known flood values or those determined from the maximum levels are situated below those points. So, for Cambanbe, (Cuanza river), the flood discharge was fixed in 10 000 m³/sec, though the discharge calculated by means of the maximum known levels does not go above 4 000 m³/sec. That is to say that, regarding the shortness of elements, the criterion used by the designer is the choice of prudent values.

- 4 - The low flood discharge values registered in the tropical regions seem to have the main justification in the characteristics of the great rainfalls of such regions, especially the discontinuities observed in space and time, in opposition to the continuity existing in the frontal rains of the

temperate regions, since that, in such conditions, not all the watershed is contributing for the increase of the maximum flood discharge and the run-off coefficients are low.

Of course, different will be the case when all the watershed is interested in the shower, what may happen in small river basins, of the order of magnitude of some Km², or else in the case when the main direction of the river is coincident with the displacement of the "rainy zones".

- 5 - The climatic characteristics, principally the high temperatures verified on occasion of great rainfalls, are the main factors responsible for the laterisation of the superficial rocks.

The geomorphology of these soils causes the infiltration of water and subsequent underground basins, that, besides decreasing also the maximum flood discharges, regularize the annual flow and produce high summer discharges. These are other peculiar characters of the african rivers flow that it is of interest to know, as long as more economic projects may result from their study - f.i., facilities for annual and inter-annual regulation and permanent or of great constancy discharges of high values.

- 6 - In the West Africa and especially in the rivers running in the Angola plateau, the longitudinal profiles have, as a general rule, the steeper gradients near the coast, and across waterfalls and rapids. In the upstream and downstream part of this zone the rivers deposit a great amount of sediments, carried down mainly by the flood discharges of the smaller tributaries, and it is through such deposits that the lower river bed meanders, over flowing the higher bed in high water periods and there forming lagoons.

From here results a reinforcement of the peculiar flow characters referred to in 5, by means of the constitution of large natural basins that decrease still more the flood peaks.

We think that the weak flood discharges together with the small gradients are the factors responsible for the formation of such morphologic characteristics, since that, by such means, it is not possible to have in the flood period large current speeds able of deepening and straightening the lower river bed.

The examination of the discharge duration curves of the Cuanza river in Cambambe, from which the one corresponding to the hydrological year of 1955/56 is shown in Fig. III, shows that:

- (i) The average annual discharge is nearly equal to the semi-permanent discharges, for a dry season extending for about 5 months.

(11) The ratio between the maximum and minimum discharges is around 10/1, showing therefore characteristics of little torrentiality.

(111) The integral discharge of the dry season reaches about 30% of the integral annual discharge.

All these conclusions confirm the existence of big superficial and underground basins that regularize the flows, absorbing a large part of the rainy season discharges to give them back in the dry season, and are, after all, the result of the climatic conditions existing in the tropical regions.

7 - In conclusion:

- a . The climatic features, in special the type of precipitation, are the main responsible factors for the low flood discharge values occurring in the tropical regions of the West Africa.
- b . It is of interest to intensify the collecting of data and the research about rainfalls and flows since it will derive from that a large benefit for the economy of the hydraulic projects to carry out in the tropical Africa.
- c . It is desirable to try to determine involving curves for the maximum discharge floods obtained in african regions with similar climatic characteristics, an international co-operation in this field being helpful.

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- (1) - F. Bultot, Sur le caractère organisé de la pluie au Congo Belge, Bruxelles (1952), INEAC.
- (2) - D.H. Johnson, Patterns of daily rainfall over East Africa, Nairobi (1961), CCTA.
- (3) - D.H. Johnson, Rain in East Africa, Quartely Journal of the Royal Meteorological Society, vol. 88, (375), Jan., 1962.
- (4) - Aménagement a fins multiples des bassins fluviaux - lère partie - Manuel de mise en valeur des bassins fluviaux, New York (1957), Nations Unies - Commission Économique pour l'Asie et l'Extrême-Orient.

FIG 1
COMPARISON OF RANFALL INTENSITIES
mm/hour

PERIOD (min.)	BEIRA (1)	BEIRA (2)	L. MARQUES (2)	LUANDA (2)	LISBOA (2)	DE BILT (2) c	TORONTO (2) b	NEW ORLEANS (2) a
10	165	157	180	134	79	33	-	173
20	153	136	-	103	58	27	85	135
30	136	120	114	89	45	22	71	114
60	103	89	72	66	30	-	44	79
120	61	55	50	53	20	-	31	53

PERIOD (min.)	PENSACOLA (2) a	HOUSTON (2) a	MOBILE (2) a	PORTLAND (2) a	PHILADELPHIA (2) a	TACOMA (2) a	BALTIMORE (2) a	S FRANCISCO (3) a'
10	178	184	183	58	137	48	160	59
20	147	150	140	41	100	32	114	41
30	109	123	114	32	81	23	96	30
60	90	86	76	19	50	15	56	24
120	64	56	46	12	30	10	47	14

a) Rainfall Intensity - Duration - Frequency Curves, M.S. Department of Commerce, Weather Bureau, Technical Paper n°. 25, Washington, D.C., December 1955

b) J.P. Bruco, Ciro 3030, Meteorological Branch-Department of Transport, Canada.

c) Levert, Rains - A statistical study, Koninklijk Nederlands Meteorologisch Instituut (1954)

d) Arantes e Oliveira, O regime de chuvas em Lisboa. Observatório Infante D. Luis, (1942)

(1) Frequency 1/20
(2) " 1/5
(3) "

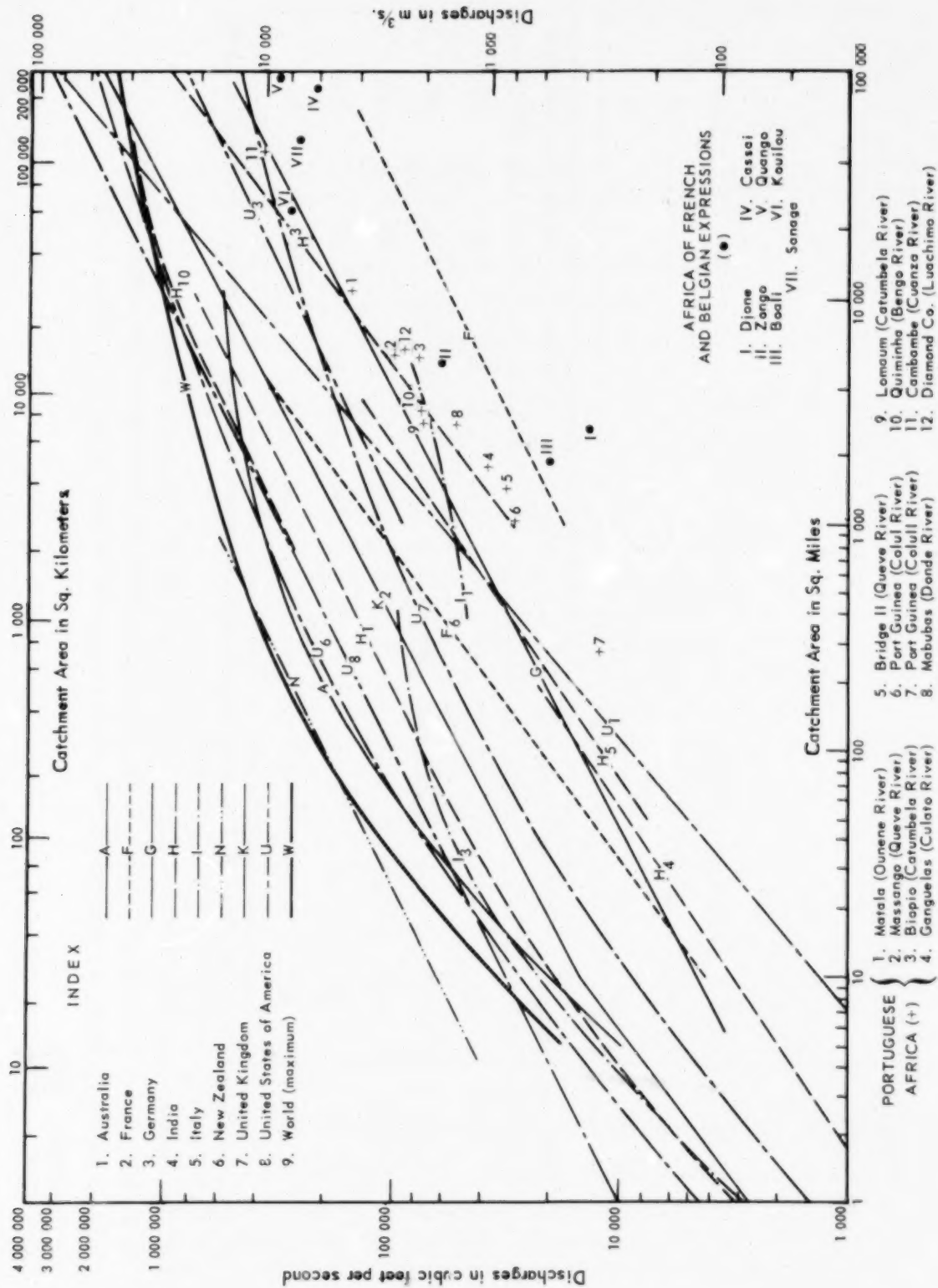


Fig. III — FLOOD DISCHARGES
(Extracted from fig. 5 of publication (4), that compares the formulae generally used to estimate floods)

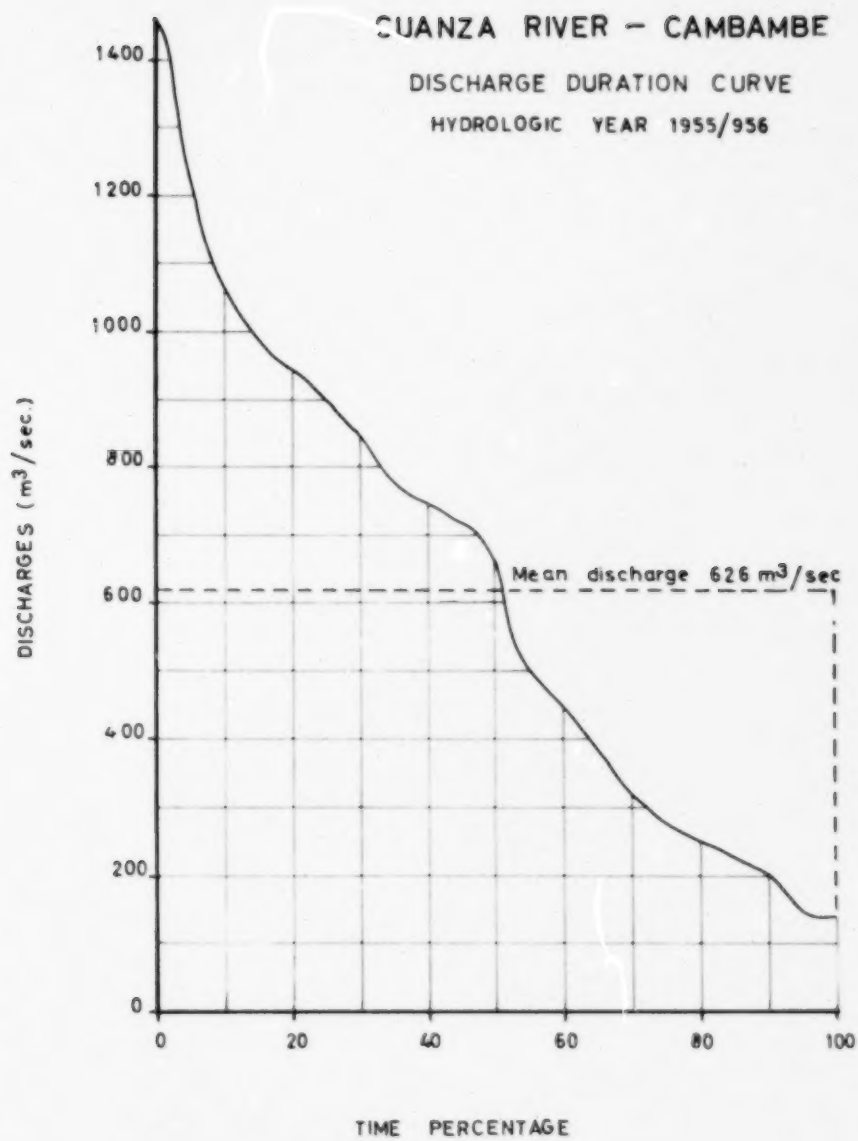


FIG III

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